Module 5: Transit Operations Software

TRANSIT MANAGEMENT TRAINING ROADMAP	
	Module 1: Introduction to ITS and APTS
	Module 2: Automatic Vehicle Location Systems
	Module 3: Automated Transit Information
	Module 4: Transit Telecommunications
	Module 5: Transit Operations Software
	Module 6: Paratransit Computer-Aided Dispatch
	Module 7: Electronic Fare Payment
	Module 8: Technologies for Small Urban and Rural Transit Systems
	Module 9: Stages of ITS Project Deployment
	Module 10: What Can ITS Do for Me?

Technologies:
- Intelligent vehicle logic unit
- Mobile data terminal
- Automatic passenger counter
- Mapping/GIS software
- AVL/GPS

Applications:
- Computer aided dispatch
- Supervisory control and data acquisition
- Service monitoring

Where Transit Operations Software is happening:
- Bus Transit control centers
- Rail control centers

Module 5: Transit Operations Software
1.5 Hours

Introduction

Schedule

The following table shows the times and activities for this module.

Time	Activity/Topic
3 min.	*Lecture/Discussion:* Introduction
12 min.	*Lecture/Discussion:* What Is Transit Operations Software?
20 min.	*Lecture/Discussion:* Technologies: Bus
15 min.	*Lecture/Discussion:* Applications: Bus
10 min.	*Lecture/Discussion:* Applications: Rail
30 min.	Exercise 5-1: Custom Course Notes
90 min.	Total Time

To prepare

Have the sample IVLU on a table for the students to look at in this module.

Continued on next page

Introduction, Continued

Slide: Goal

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Goal

Explain the goal.

Say: This module will focus on two areas of Transit Operations Software, namely, fixed route bus and rail.

- Paratransit applications, because of their flexible nature, rely heavily on operations software and as such will be discussed separately in Module 6.

Objective

Read the module objective:

- Given an APTS Technology Reference table, students will list three benefits of using Transit Operations Software in their agency.

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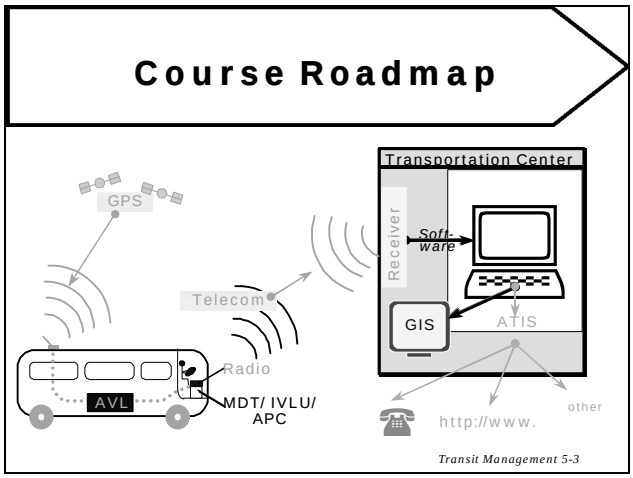
Introduction, Continued

Slide: Course Roadmap



Orient with the roadmap

Show the class where they are with the roadmap on page 1 of their SG.

Ask which of the three parts of the ITS Infrastructure which we introduced in Module One will Transit Operations Software fit into:

- traveler information
- transit fleet management
- electronic fare payment
- Answer: transit fleet management

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Introduction, Continued

Issues

Say: One issue facing transit as integration of systems becomes more necessary is the compatibility with existing exterior systems, e.g.:

- planning and operations databases do not match up with
  - ◊ FCC and Public Safety
  - ◊ National Architecture

The industry is beginning to demand this compatibility, and it is one thing to keep in mind when thinking about upgrading any of your systems. We'll discuss how this issue affects Transit Operations Software in this module.

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Introduction, Continued

Slide: Module Outline

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Module outline

Say: This module will:

- define and describe Transit Operations Software
- show technologies and applications available for both bus and rail

What is Transit Operations Software?

Length 12 minutes

Slide: What is Transit Operations Software?

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What is Transit Operations Software?, Continued

What is Transit Operations Software?

Explain.

Say: Transit Operations Software includes the software located in a transit control center that enhances processing of transit information.

This kind of software is being applied in bus, rail, and paratransit applications. The software generally:

- works in real-time with immediate transit situations
- assists dispatcher in synthesizing large amounts of data to maintain service
- affords rapid processing of data and immediate telecommunications for:
  - ◊ real time dispatch
  - ◊ rapid response to disruptions
  - ◊ coordination among modes of transportation
- enables the integration of various systems
  - ◊ information can be shared with other systems
  - ◊ integration of systems is a key benefit if ITS

Say: Integration among modes is a benefit of what these kinds of information systems can do. This is key to what we are trying to encourage.

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What is Transit Operations Software?, Continued

Custom software

Explain how software is customized to an agency.

Say: Information systems for transit operations have no ideal, approved format at this time. Generally, any of the software systems that would be called "operations software" are customized to meet the needs of the transit system.

Factors that affect the software systems include:

- route structure
- the types of integrated fleet management applications that will be included, such as data collection from in-vehicle units, APCs, next stop annunciators, etc.
- availability of funding

A common benefit of transit operations systems is the focus on customer satisfaction and enhancing operations. The software is always dependent upon accurate vehicle location and a two-way communication system between vehicles and the control center.

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What is Transit Operations Software?, Continued

What it is not

Explain the difference between Transit Operations Software (TOS) and static software systems the students may use in their agencies at present.

Say: Non-real-time software that provides long term planning and scheduling is **not** included as part of Transit Operations Software because of its "static" nature.

- Naturally, planning and scheduling functions can be included in operations software, but stand-alone static systems are not what we are talking about in this module.

Explain that the hope is that information from TOS will be used as inputs to the non-real time software, such as run-cutting, to eventually improve operations.

- Some agencies are starting to do this now.

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What is Transit Operations Software?, Continued

Class question

Ask: Many of you probably use software that is not hooked up to a real-time source of data to help with making schedules or planning routes.

- What kind of systems do you have like this?
- Do you use any type of scheduling software?
- Does it have any links to real-time data systems?

Introduce benefits

Write on the easel:

- Safety
- Operations
- Customer service

Say: Let's talk about the potential benefits of Transit Operations Software. Now, we'll look at general benefits of any transit operations information system. Later in the module, we'll look at specific benefits for bus and rail systems.

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What is Transit Operations Software?, Continued

Slide: Benefits

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What is Transit Operations Software?, Continued

Benefits

Explain general benefits of software for transit operations.

- Transit Operations Software are the building blocks that will allow for integration of bus and rail systems.

- Safety is increased by handling emergency situations faster through:
  - ◊ quicker assessment and location
  - ◊ faster response times
  - ◊ improved coordination with other agencies

- Reliability and efficiency are improved by:
  - ◊ monitored arrival and departure times
  - ◊ providing right vehicle in right place at right time
  - ◊ affording real-time adjustments to routine traffic flow and to incidents
  - ◊ improved scheduling reliability
  - ◊ the software which triggers announcements for ADA (Americans with Disabilities Act) compliance

- Customer convenience is improved by:
  - ◊ audio and visual announcements complying with ADA
  - ◊ offering a dependable and convenient transit alternative to automobile travel

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What is Transit Operations Software?, Continued

Slide: Transit Operations Software Applica-tions

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Transit Operations Software Applica-tions

Explain that the two applications we will talk about in this module are:

- fixed route bus
- rail

Ask the students if they recall another major application in transit of Transit Operations Software.

- **Answer**: Paratransit, which we will be discussing in the next module.

Transit Operations Software applications are also being used by alternative services such as ferries, people movers and shuttle services.

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What is Transit Operations Software?, Continued

Slide: Transit Operations Software Deployment

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Deployment

Say: There are at least 25 sites throughout the United States that currently employ operations software.

- Most serve large metropolitan areas, but not all.

Say: Those shown on the slide are just a sample of the sites to show you that the cities are across the nation and vary in size.

Technologies: Bus

Length 20 minutes

Slide: Fixed Route Bus Tech-nologies

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Fixed route bus outline

Read the slide bullets.

Ask questions to see how familiar the class is with bus technologies listed on the slide, e.g.:

- Does anyone have buses equipped with IVLUs?

Ask several more questions for each of the technologies on the slide.

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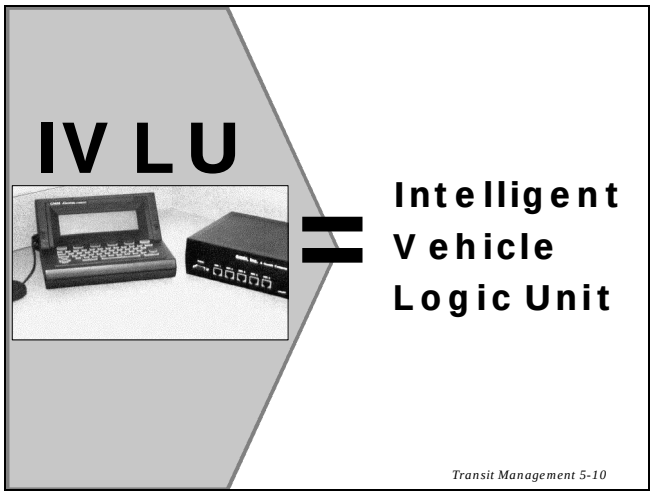
Technologies: Bus, Continued

Slide: IVLU



IVLUs

Explain slide and acronym.

IVLUs typically have a display unit and a receiver/processing unit.

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Technologies: Bus, Continued

State-of-the-art IVLU

Say: An Intelligent Vehicle Logic Unit (IVLU) contains hardware and software and is placed on the bus to combine automatic vehicle location (AVL) and fleet management.

Most schedule adherence takes place on board, not at dispatch. Calculation for schedule adherence is actually being done on board, e.g., as part of exception reporting.

- The software on the vehicle
  - ◊ processes data transmitted from navigational satellites
  - ◊ decodes it into latitude and longitude coordinates
  - ◊ takes into account other positional data (dead reckoning, differential corrections)
  - ◊ forwards corrected data to the control center

- The control center
  - ◊ processes the data from the vehicle
  - ◊ converts the location into map coordinates
  - ◊ displays the location of the vehicle on the dispatcher's screen

IVLU needs route and schedule data input to function. State-of-the-art IVLU software can do schedule/route adherence computations as well as location computations.

Show the IVLU to the class.

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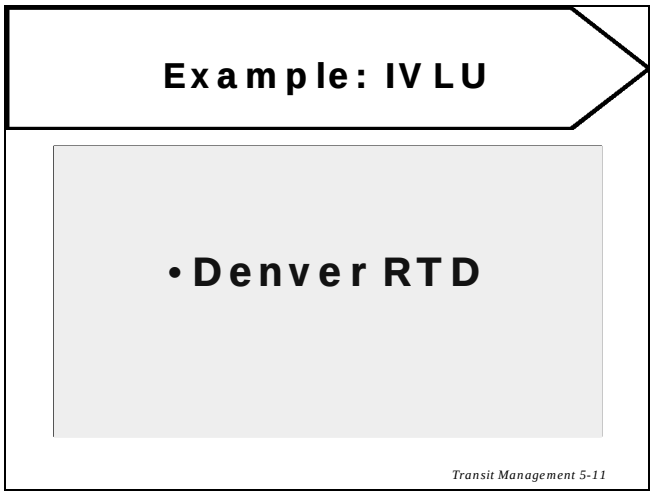
Technologies: Bus, Continued

Slide: Example: IVLU



IVLU example

Say: The RTD of Denver has the following features tied to the IVLU equipment:

- Intelligent vehicles receive signals from satellites, decoded to longitude and latitude.
- Information is transmitted via radio to operations center.
- Dispatcher at center studies computer map display, which shows vehicle, route, and schedule adherence condition.

For more information, refer to *Update 96* p. 39-40 and *Update 98* p. 2-18.

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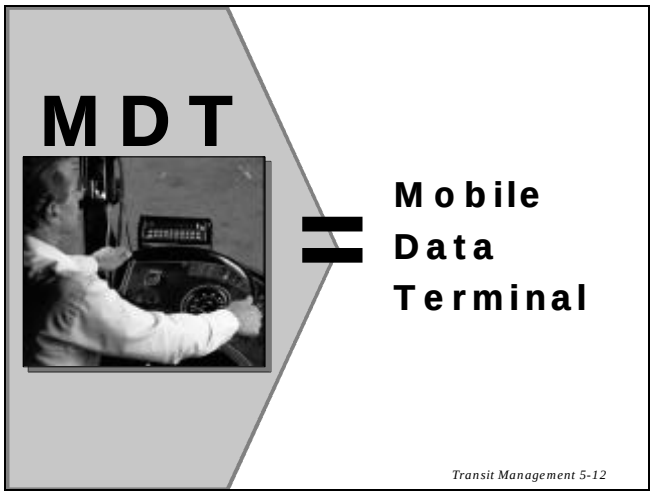
Technologies: Bus, Continued

Slide: MDT



Mobile data terminal

Explain mobile data terminals:

Often, the transit vehicle's IVLU will be a mobile data terminal (MDT) on board that communicates with dispatch.

This MDT can collect, store, and in some cases, process data on-board the vehicle, as well as send the information back to the transit control center.

An MDT is used to communicate information to and from the driver, such as:

- a 'panic button' for the driver to press to call for help in the event of a problem
- schedule adherence information
- messages from dispatch
- messages the driver can send to dispatch, such as maintenance problems or accidents

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Technologies: Bus, Continued

MDT vs. IVLU

Explain the difference between IVLU and MDT:

The In-Vehicle Logic Unit (IVLU) is a unit aboard the bus that integrates the position information from GPS and other supplementary position location sensors and interfaces with communication and display devices.

The Mobile Data Terminal (MDT), sometimes referred to as the control head, is a device normally mounted in view of the driver that displays text information to the driver and allows driver input of data to be sent to the transit management center.

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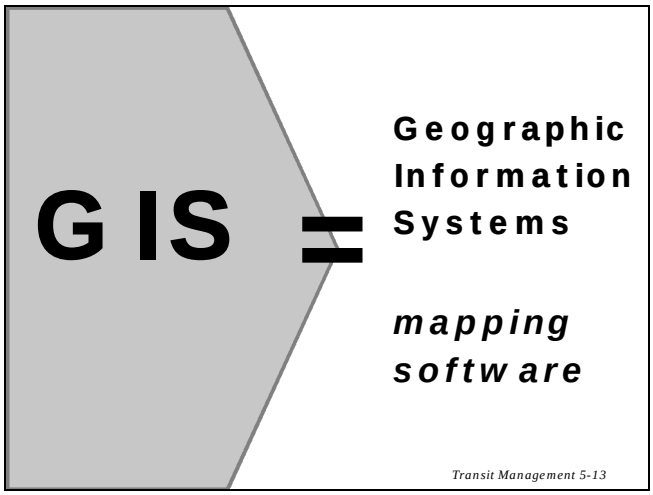
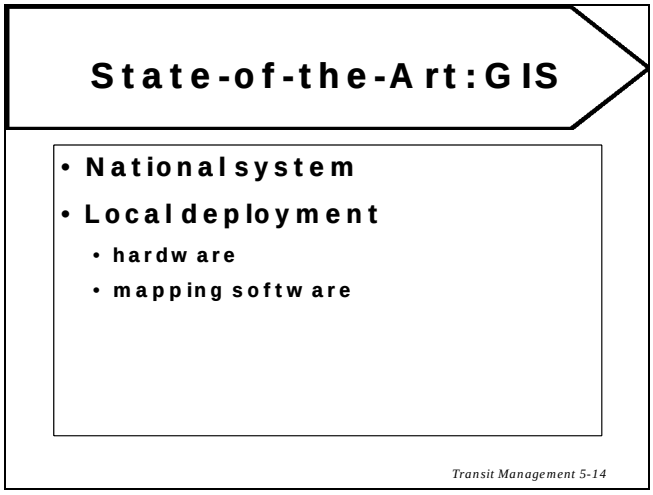
Technologies: Bus, Continued

Slide: GIS



Slide: State-of-the-Art: GIS



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Technologies: Bus, Continued

GIS

Explain that Geographic Information Systems being used at a bus transit control center are normally a local implementation of a state or national mapping system.

In general, a GIS mapping system is a combination of an electronic map and a database.

Most AVL/CAD systems have their own GIS.

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Technologies: Bus, Continued

Note to instructor: National GIS system vs. Transit GIS

Note to instructor: *Do not discuss this information at this time unless students ask. Explain briefly, then say that more complete information is available in Module 9.*

The national transit Geographic Information Systems initiative promotes coordination from the top as well as with other government agencies at the same level, such as:

- highway
- regional/city planning
- police
- fire
- other transit agencies

For an integrated ITS system, a common GIS must be in place.

Through a collaborative effort, the FTA is creating a National Transit Geographic Information System (GIS), which is a representative inventory of the public transit assets of the country. Besides inventory, it will include:

- geographic information
- maps
- population information

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Technologies: Bus, Continued

Local deployment

Explain how GIS is used locally.

Say: Even if you're not ready to integrate on a national scale, regional or local coordination and cooperation is essential to consider.

Elements of a locally deployed GIS mapping software system include groups of different data elements which are not related, for example:

- population centers
- road networks
- rail lines
- transit passenger stops

Each database group is like an overlay, which can be placed on the map electronically in various ways.

- For example, the location of bus stops can be overlaid on a map that shows the population bases of a region to see if the bus stops are located effectively.

A local geographic information system at a transit control center might consist of:

- computer hardware
  - ◊ modem, printer, computer, display screen, telecommunications equipment
- software for analysis of relationships and interface with databases
- assorted data packages in the database
- operators/users (including computer support)

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Technologies: Bus, Continued

GIS applications

Say: Possible fixed route bus applications of GIS include:

- in transit bus operations
  - ◊ bus routes
  - ◊ streets
  - ◊ facilities (servicing, fire, police, medical)
  - ◊ bus stops/shelters
  - ◊ accident and incident locations
  - ◊ population centers (parks, apartments, theaters, stadiums, hospitals)

- in transit bus servicing
  - ◊ streets
  - ◊ bus routes/stops
  - ◊ parking lots
  - ◊ facilities

- operator route training (assistance provided by dispatch)

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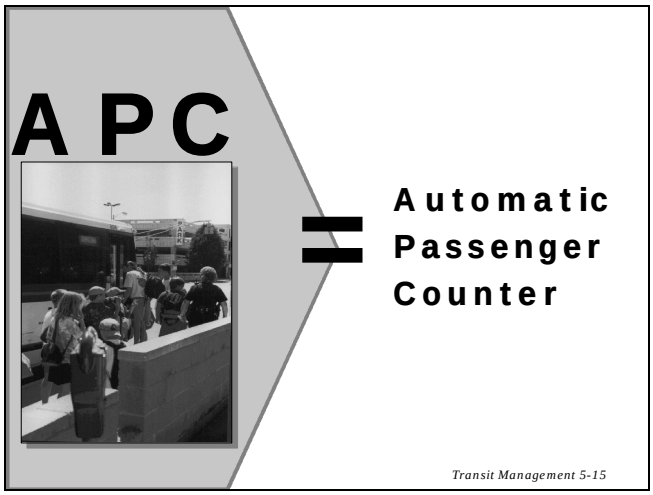
Technologies: Bus, Continued

Slide: APC



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Technologies: Bus, Continued

APCs

Explain APCs:

Automatic passenger counters are a well-established, automated means for collecting data on passenger boardings and alightings by time and location. Typically, between 10 and 20 percent of an agency's buses are equipped.

An APC has three basic components:

- counter
  - ◊ capable of counting each passenger as they board and alight and distinguish between boardings and alightings
- location technology
  - ◊ capable of determining the bus' location at least at the time boardings and alightings occur
- data management
  - ◊ capable of storing the data long enough so that it can be transferred from the vehicle

The two most prevalent types of counters are treadle mats and infrared beams.

Source: APTS State-of-the-Art Update '98, p. 2-25

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Technologies: Bus, Continued

Uses and benefits

APC data may be used for a number of applications, both real-time and delayed, including:

- input to dispatcher decisions on immediate corrective action
  - ◊ e.g.: short-turn the empty bus
- input to real-time passenger information systems
  - ◊ e.g.: "two buses are coming on the #7 route, the first is five minutes away and full and the second is eight minutes away and nearly empty"
- National Transit Database reporting of passenger trips and passenger miles; formerly known as "Section 15 reporting"
- future scheduling
- positioning new shelters for waiting passengers
- fleet planning

It is anticipated that APCs will achieve the following:

- Decrease data collection costs
- Increase the type and range of data available
- Decrease time and effort required to process collected data
- Increase overall operating efficiency due to better service planning
- Provide data to passenger information systems

Source: APTS State-of-the-Art Update '98, p. 2-27

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Technologies: Bus, Continued

State-of-the-art APCs

The first generation of APCs was deployed over 25 years ago. Since these systems predated not only modern AVL systems, but also nearly all of the computer and digital radio technology now utilized, their applications were limited to scheduling, planning, and similar functions. Although the technology of the 1990s is far more dazzling than these old systems, the APCs of the 1970s still provided accurate data more quickly and at a lower cost than could be achieved with manual data collection by human checkers. Some of these systems are still in use, often with updated equipment.

An agency installing an APC system in the 1990s is most likely to be putting it in as part of an AVL system. Whether or not the agency takes advantage of collecting the data in real time, the ability to make use of existing location and/or data transmission technology greatly decreases the capital cost of the APC system and makes it more fiscally feasible.

Source: APTS State-of-the-Art Update '98, p. 2-27 and 2-28

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Technologies: Bus, Continued

Example: Tri-Met, Portland, Oregon

Explain example:

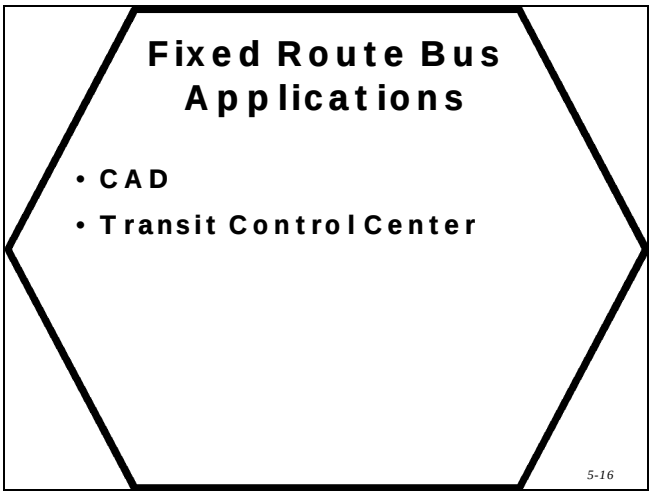
Tri-Met's system became operational in 1982 and cost $4,500 per APC. Location was determined by combining time with knowledge of schedule and layover points. Plans call for expanding the number of APCs to 20 percent of the fleet (currently on 80 of Tri-Met's 635 buses). Today, the new counters are much cheaper, costing only about $1,000 per bus. The APC system has been linked to Tri-Met's ACL system, which provides much more accurate location information than did the old method. Finally, there also have been advances in retrieving the data from the bus. Now they are transmitted along with the AVL data over the reserved radio frequencies, although the data are still not used in real time. Formerly, data was retrieved by special units, which collected the data automatically from each APC-equipped bus via infrared link when the bus returned to the garage.

Tri-Met states that the APCs provide easier and quicker access to passenger data and are less expensive than manual counting.

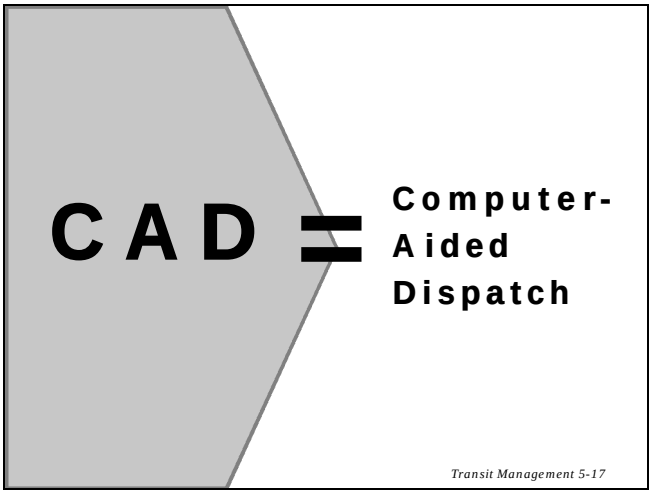
Source: APTS State-of-the-Art Update '98, p. 2-29

Applications: Bus

Slide: Fixed Route Bus Applications



Slide: CAD



CAD

Remind the students that CAD stands for computer-aided DISPATCH (NOT computer aided design).

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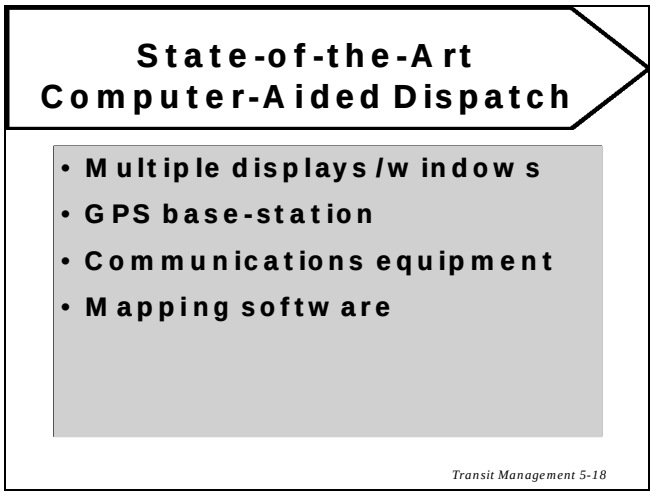
Applications: Bus, Continued

Slide: State-of-the-Art Computer-Aided Dispatch



Class questions

Ask questions to see how familiar the class is with CAD technology, e.g.:

- Are any of you aware of agencies that use computer-aided dispatch?
  - ◊ Does it work well?
  - ◊ How long has the system been in place?

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Applications: Bus, Continued

Computer-aided dispatch

Explain that computer-aided dispatch applies to Transit Operations Software for both bus and rail, though it is more commonly used in reference to bus operations.

The key to computer-aided dispatch is the computer software which controls the following:

- the activity of various processing computers
- a global positioning system (GPS) base-station which receives latitude and longitude coordinates from transit vehicles, converts that data into map coordinates, and plots the locations on the display map geographic information system (GIS)
- a telecommunications network consisting of two-way data and voice communication between control center, vehicles, and passenger/service transit stations
- a situation map which displays location, status, and schedule adherence of all vehicles in the system

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Applications: Bus, Continued

In the past

Explain that "paired computers" or "paired displays" were two computers at the control center that were used for decision-making and status display. They usually worked with various peripherals, such as:

- modems
- display terminals
- printers

The two primary functions controlled by the dispatch paired computers are:

- the collection/processing of transit data from external sources by one computer
- the control center display of processed information by the other computer

These two functions were sometimes displayed on two different monitors.

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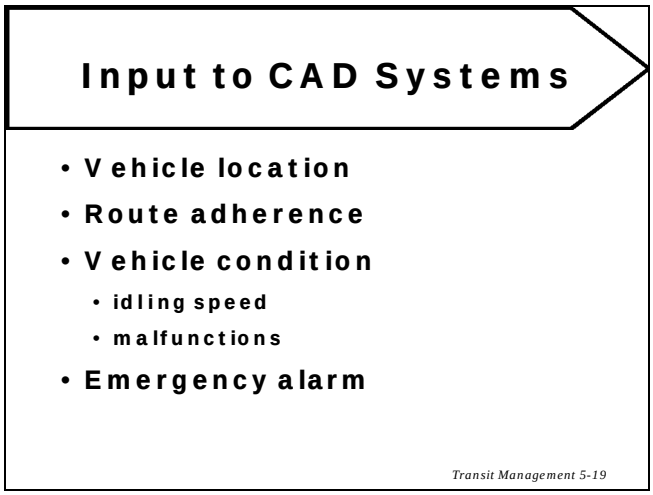
Applications: Bus, Continued

Slide: Input to CAD Systems



CAD input

Explain that CAD replaces the older technology by displaying and integrating both sets of information on one screen for each usage site (i.e., one on-board and one for a single user in dispatch).

Say: Data which is collected from vehicles and stations and processed on the first computer include:

- location of all transit vehicles
- route/schedule adherence (early/on time/late)
- condition of vehicles
  - ◊ idling speed
  - ◊ malfunctions
  - ◊ emergency alarm (overheating/pressure systems, fire)
  - ◊ passenger/fare count
- emergency alarm

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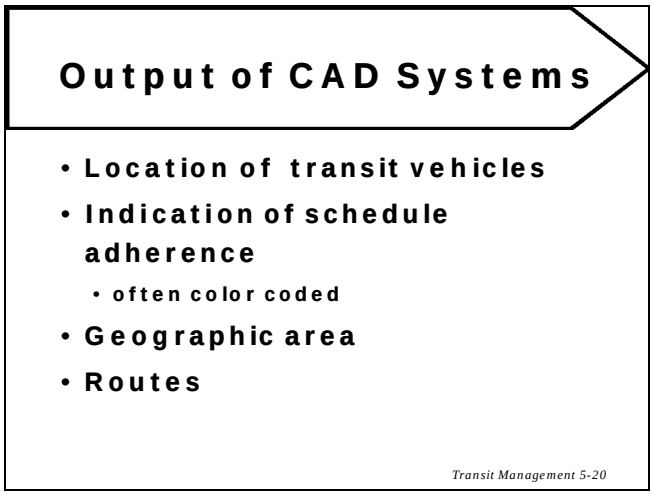
Applications: Bus, Continued

Slide: Output of CAD Systems



CAD output

Say: Information from transit operations software that dispatch uses includes:

- location of transit vehicles updated at a periodic interval, such as every two minutes for routine activities and every 30 seconds during emergencies
- vehicles colored to conform to schedule adherence status
- geographic area with streets, tracks, stops, and major sites
- routes of transit vehicles
- location of emergency/service vehicles and facilities
- passenger count
- telecommunications information

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Applications: Bus, Continued

Advantages and dis-advantages discussion

Ask the following questions and write the answers on the board:

- How do you think computer-aided dispatch could benefit the passenger?
- How can it benefit the agency?
- What will you do to your operating costs if you have to switch from the manual functions being performed currently to a system that uses transit operations software for bus applications?
- What will it do to your staffing and training needs?
- Can you think of any risks?

Review the answers.

- **Say**: Let's compare your answers with our slides.

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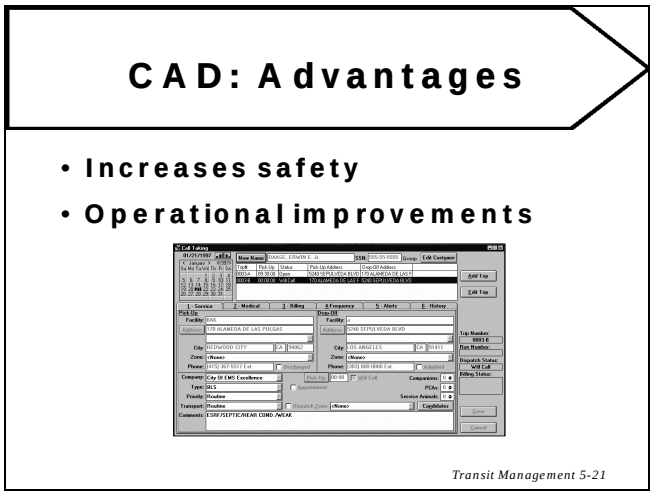
Applications: Bus, Continued

Slide: CAD: Advantages



CAD advantages

Review any item on the slide not yet covered.

Explain that CAD systems help to improve operations by aiding the dispatcher in processing information. Also, the safety is increased by the use of technology like the mobile data terminals (MDT), which give the operator of the vehicle instant communication with the control center in the event of an emergency.

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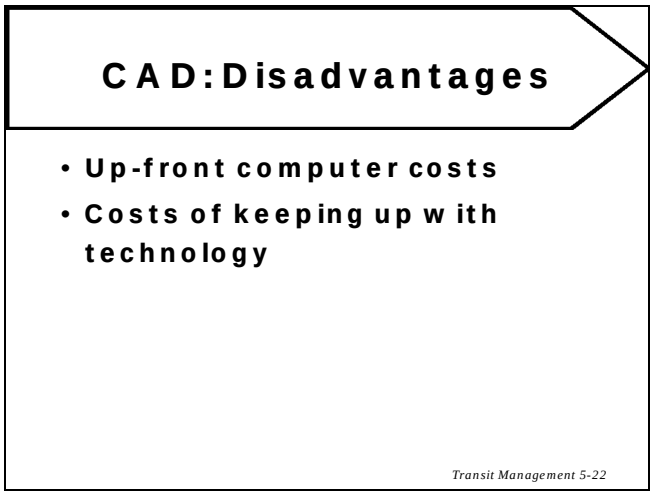
Applications: Bus, Continued

Slide: CAD: Dis-advantages



CAD dis-advantages

Review any item on the slide not yet covered.

Disadvantages include:

- up-front computer and installation costs
- ongoing maintenance costs of technology
- system failures:
  - ◊ You need to have backup systems in case the primary system fails.

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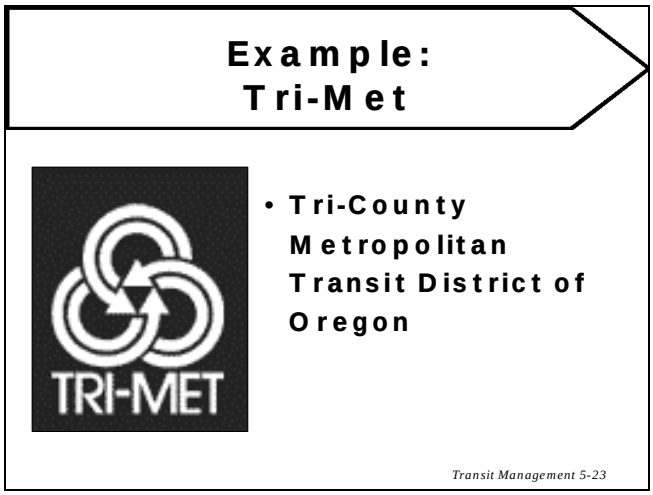
Applications: Bus, Continued

Slide:
Example:
Tri-Met:



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Applications: Bus, Continued

Tri-County Metro-politan Transit District of Oregon

Tri-Met has been using CAD since July 1996. The CAD system uses:

- exception reporting
- a five-minute default polling cycle, referred to as a "health report"

Features of the Tri-Met system include:

- variable on-time window
- silent alarms
- emergency and priority messaging

The Vehicle Logic Unit (VLU) controls:

- luminator destination signs
- automatic passenger counting
- mechanical diagnostics
  - ◊ VLUs can be programmed to automatically transmit the data to the bus dispatch center

Tri-Met is working with Portland State University to do an evaluation of:

- on-time performance
- trip times
- vehicle spacing during peak periods

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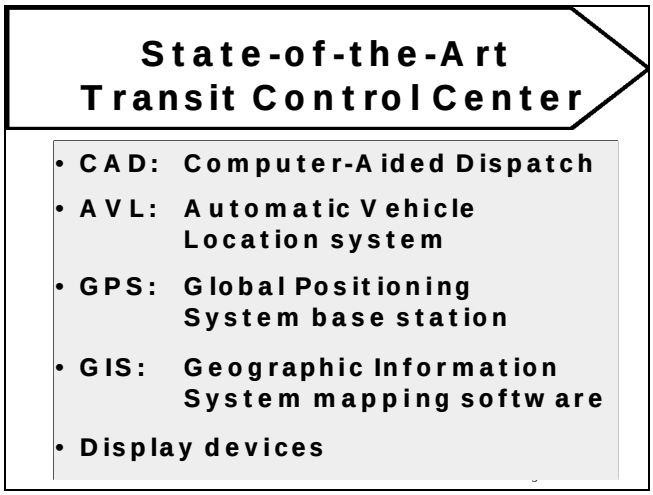
Applications: Bus, Continued

Slide: State-of-the-Art Transit Control Center



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Applications: Bus, Continued

State-of-the-art transit control center

Build the slide and **ask** the students to identify each acronym as it appears. **Explain** how these work together:

Transit Operations Software in the transit control center assists the dispatcher to:

- Monitor location, schedule adherence, and status of each vehicle in the system in real time
- Direct individual vehicle adjustments in inclement weather and emergencies. The dispatcher can:
  - ◊ reroute the vehicle
  - ◊ add a vehicle to the route
  - ◊ dispatch a replacement vehicle
- Adjust bus schedule and coordinate with other transit modes
- Provide timely oral and visual transit information for operators and customers
- Augment service restoration:
  - ◊ adjust vehicle dwell time at particular stops/locations (e.g., transfer points)
  - ◊ adjust vehicle schedule/headway
  - ◊ perform traffic signal priority

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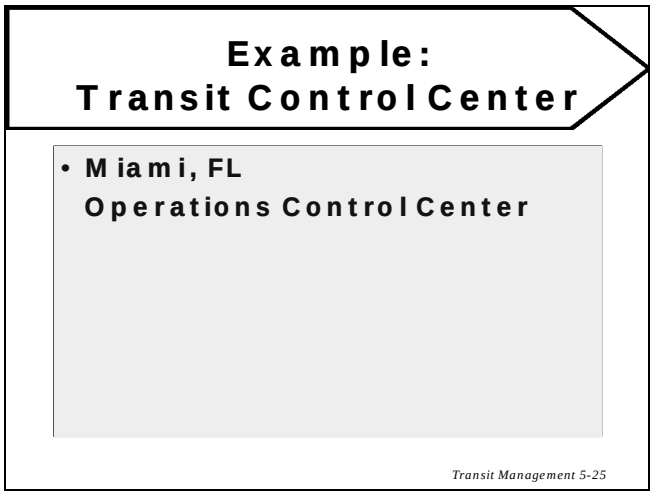
Applications: Bus, Continued

Slide: Example: Transit Control Center



Transit control center example

Explain the example to clarify the definition of a Transit Control Center.

In Miami, Florida, the Operations Control Center of the Metro-Dade County Transit Agency tracks 800 transit vehicles.

- Each bus has a schedule in its on-board computer that relays the progress of the bus to the control center every two minutes.
- At central control, an electronic map of Dade County displays the vehicle, its route number, and direction of travel.
- As information is received at the control center, the vehicle route number is assigned colors on the map to denote if the vehicle is ahead, behind, or on schedule, or if an emergency is occurring.
- Dispatchers can contact the operators to give direction on schedule adherence, or they can contact law enforcement agencies in case of an incident.

Continued on next page

Applications: Bus, Continued

Integration

Integration is the key to maximizing the effectiveness of a transit control center. The goal is to:

- move away from the existence of many transit control centers that communicate exclusively via the telephone
- integrate all systems used by a number of different transit control centers to create a system

When implementing a new system, it is important to make sure it is compatible with other systems within the region so it can be integrated with existing systems. For example, regional GIS is valuable. Problems arise when there are different types of GIS within the agency, the region, and between the FHWA and the FTA. Houston, TX is one example of a transportation control center that houses both highway and transit function.

Ask the students if any of their agencies have a transit or transportation control center:

- Does anyone work at an agency that has a bus transit control center?
  - ◊ Is it an intermodal center or is it linked to other kinds of outside agencies? With whom do you share information?
  - ◊ How does it work?

Continued on next page

Applications: Bus, Continued

Advantages and dis-advantages discussion

Ask the following questions and write the answers on the board:

- How do you think Transit Operations Software for fixed route bus could benefit the passenger?
- How can they benefit the agency?
- What will it do to your operating costs if you have to switch from manual functions being performed currently to a system that uses software?
- What will it do to your staffing and training needs?
- Are there any risks you can think of?

Review the answers.

- **Say**: Let's compare your answers with our slides.

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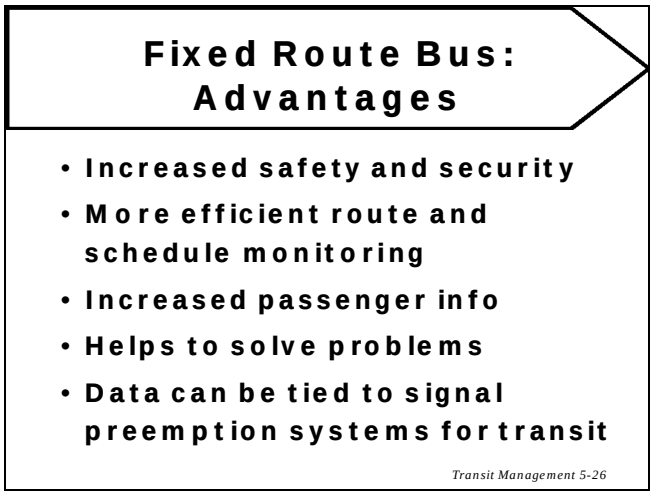
Applications: Bus, Continued

Slide: Fixed Route Bus: Advantages



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Applications: Bus, Continued

Fixed route bus: advantages

Review any item on the slide that was not covered already.

Transit Operations Software for fixed route buses have the following advantages:

- In monitoring bus location and schedule adherence for an entire system, the decisions made by the dispatcher:
  - ◊ are not made in isolation
  - ◊ allow allocation of all resources of the transit system
  - ◊ provide opportunity for coordination among numerous separate elements
- In case of an incident, real-time vehicle location and detection software allows the dispatcher:
  - ◊ to provide appropriate responses
  - ◊ to consider information/warnings to be passed to passengers
  - ◊ to prioritize outside agencies (police/fire/medical) for coordination
- Two-way communication software allows the dispatcher to keep resources informed.
  - ◊ Opportunity for integration with rail and other systems
- Transit operations software for fixed route bus helps dispatch to solve problems and make decisions, such as:
  - ◊ Bus bunching
- In using software for optimizing traffic with signal priority for transit, the dispatcher minimizes:
  - ◊ passenger delay and frustration
  - ◊ schedule adherence conflicts
  - ◊ delays caused by traffic incidents
- In some cases, job tasks shift for supervisors or dispatchers because of computers performing detailed task analysis.

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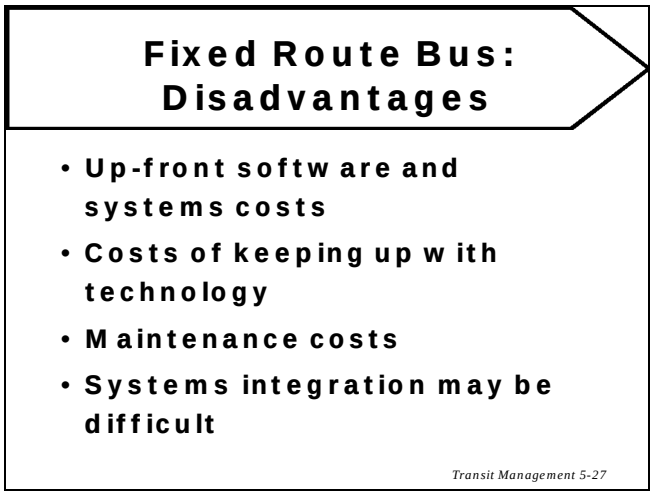
Applications: Bus, Continued

Slide: Fixed Route Bus: Dis-advantages



Fixed route bus: Dis-advantages

Review any item on the slide that was not covered already.

The disadvantages of applying transit operations software to fixed route bus are:

- up-front costs for software, systems, and support
- the continuing maintenance costs of keeping up with technology
  - ◊ training costs
- ongoing maintenance costs
- difficulty in terms of time and money to integrate systems

Applications: Rail

Note to instructor

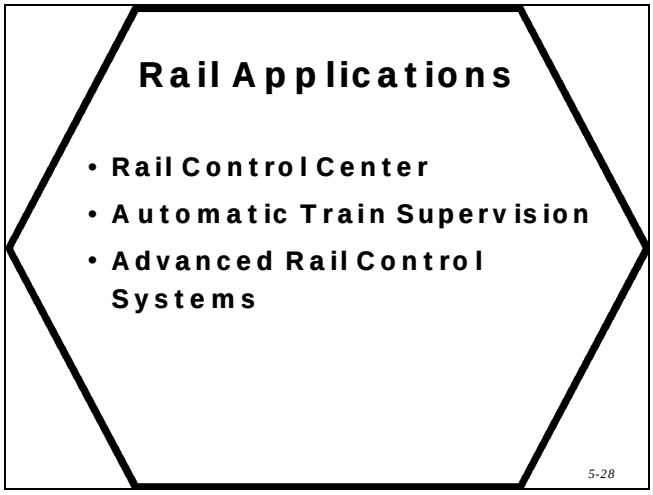
***Note to instructor**: This section is optional, or may be abbreviated, depending on the interest of the class and timing.*

If the lecture is abbreviated or shortened, refer the students to their student guide, which has a wealth of information in it.

Length

15 minutes

Slide: Rail Applications



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Applications: Rail, Continued

Rail outline

Explain that this section of the lesson looks at the three most popular technology applications of operations software for rail, including:

- rail control center
- automatic train supervision
- advanced rail control systems

Ask questions to see how familiar the class is with rail technologies listed on the slide, e.g.:

- Does anyone work at an agency that has a rail control center?
  - ◊ Is it an intermodal center or linked to other kinds of outside agencies? With whom do you share information?
  - ◊ How does it work?

Explain that planning ahead of time is key to integrating rail with other modes.

Ask several questions for each technology.

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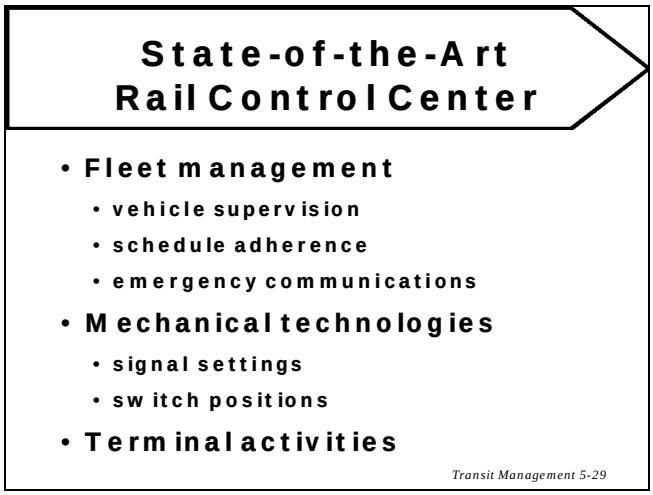
Applications: Rail, Continued

Slide: State-of-the-Art Rail Control Center



State-of-the-art rail control center

Explain that rail control center automated operations are similar to bus control centers in that they both provide:

- General fleet management, including:
  - ◊ vehicle location
  - ◊ schedule adherence
  - ◊ communication in emergency

However, rail control centers also have areas of different emphasis, including:

- mechanical technologies
  - ◊ signal settings
  - ◊ switch positions
- focus on activity in terminals
  - ◊ electronic fare collection
  - ◊ customer oral and visual information display
  - ◊ automatic dispatching and routing

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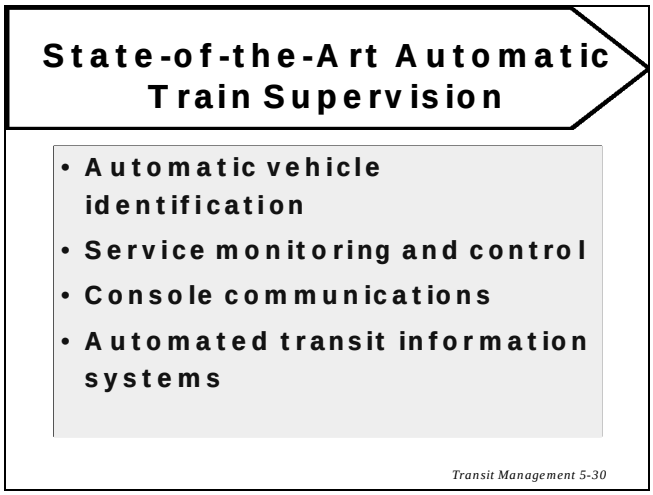
Applications: Rail, Continued

Slide: State-of-the-Art Automatic Train Supervision



Automatic train supervision

Say: Automatic Train Supervision includes several related applications, as shown on the slide:

- **Read** each bullet on the slide.
- Let's look at each one of these.

Continued on next page

Applications: Rail, Continued

Automatic vehicle identification

Say: Automatic vehicle identification is generally a combination of fleet management software and some kind of automatic vehicle location system (AVL). The software ties the technologies together.

- Identification of rail vehicles allows the dispatcher to keep track of locations and oversee schedule adherence of a large number of rail vehicles.

- Once all vehicles have been identified and locations determined, automatic dispatching and routing can take place.
  - ◊ For example, at Penn Station in New York City, 1,000 trains arrive and depart daily carrying over 600,000 passengers, making automated supervision a necessity.

Service monitoring and control

Say: Service monitoring includes automatically monitoring the mechanical systems on the train, including:

- thermostats
- emergency fan ventilation systems
- exit doors and emergency devices
- back-up systems

Console telecommunications

Say: Console telecommunications include voice and data networks coordinated at the control center.

Continued on next page

Applications: Rail, Continued

Technology integration: ATIS

Explain that automatic train supervision enhances customer information services by providing data to in-terminal and in-vehicle automated transit information systems (ATIS), including:

- oral announcements
- display terminals
  - ◊ electronic signs
  - ◊ television monitors
  - ◊ kiosks
- telephonic recorded messages
- cable TV

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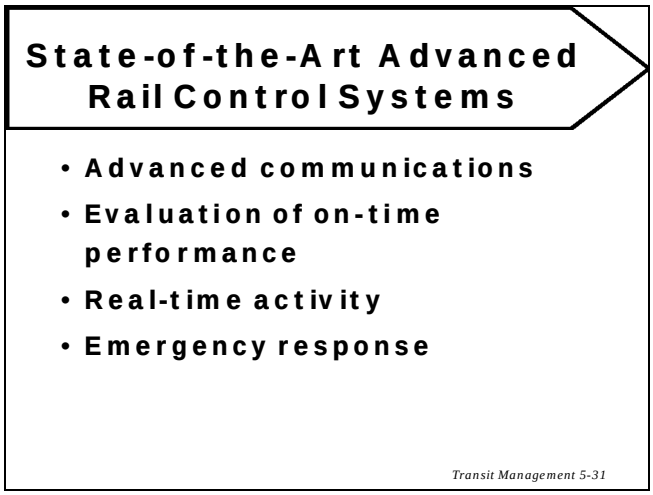
Applications: Rail, Continued

Slide: State-of-the-Art Advanced Rail Control Systems



Advanced rail control systems

Say: Operations software at rail control centers provide:

- improved information flow through efficient use of transit telecommunications
  - ◊ data channels
  - ◊ voice channels
- evaluation of on-time performance
  - ◊ immediately
  - ◊ continuously
- real-time observation and coordination by the dispatcher
- improved emergency response because the dispatcher:
  - ◊ receives status reports immediately
  - ◊ can observe all resources
  - ◊ has telecommunications to all resources for quick response

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Applications: Rail, Continued

Slide: Rail Examples

Continued on next page

Applications: Rail, Continued

Example: MBTA Boston, MA

The initial system concentrates on the rail operations, with bus being phased in later. Included features for rail:

- vehicle identification
- vehicle location
- schedule adherence
- emergency response

The Operations Control Center of the Massachusetts Bay Transit Authority (MBTA) in Boston provides:

- an amphitheater style control center with displays of rail networks, station functions, fare collection, signage, and emergency and auxiliary response systems
- console telecommunications for radio, telephone, public address, and intercom

Future expansion capabilities include integration of computer-aided dispatch, advanced vehicle locating systems, and vehicle monitoring systems.

- dispatch of 1000 buses
- bus operations dispatchers are provided digitized maps, showing route and address location information

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Applications: Rail, Continued

Example: New York City

New York City Transit has completed design and partial testing on improvements to the operations and safety of its subway system, including:

- automatic train supervision
  - ◊ real-time train tracking, monitoring and operations control
  - ◊ centralized location
  - ◊ upgrade of existing supervisory control and data acquisition system
  - ◊ equivalent to a computer-aided dispatch (CAD) system

- subway train and traffic information system (STATIS)
  - ◊ computerized version of existing paper sheets which operators use for finding schedule information
  - ◊ arrival and departure information will be incorporated in to customer information signs

- six-wire modernization
  - ◊ upgrade in the existing voice communications system
  - ◊ emergency/incident response has built-in, automatic, digital notification of emergencies
  - ◊ fire incident notification includes schematics of the subway system, detailed street maps, emergency exits, ventilation plans, etc.

- communications-based train control
  - ◊ will enhance train monitoring and control capabilities
  - ◊ wayside electronic readers
  - ◊ will use specially designed software to enable shorter headways

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Applications: Rail, Continued

Advantages and dis-advantages discussion

Ask the following questions and write the answers on the board:

- How do you think operations software for rail could benefit the passenger?
- How could they benefit the agency?
- What will it do to your operating costs if you have to switch from manual functions being performed currently to a system that uses transit operations software?
- What will it do to your staffing and training needs?
- Can you think of any risks?

Review the answers.

- **Say**: Let's compare your answers with our slides.

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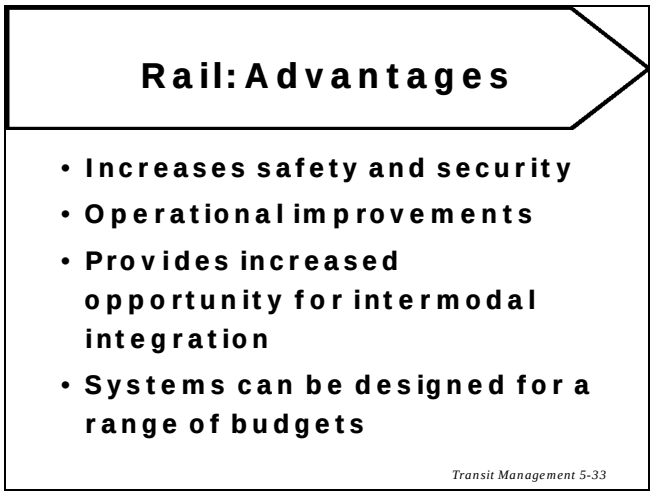
Applications: Rail, Continued

Slide: Rail: Advantages



Rail advantages

Review any item on the slide that was not covered already.

- increased safety and security
  - ◊ safe reduction of headway, but it may require more trains
- operational improvements
  - ◊ more on-time trains
  - ◊ possibly more service
  - ◊ may allow more trains, but this would increase operating costs except at peak periods
- intermodal integration
  - ◊ opportunity through technology to connect bus and rail
- unique to rail:
  - ◊ currently trains are identified through a radio sign-in
  - ◊ Most trains have some form of train/track location automation, but it approximates location or enables dispatcher to know train is between stations. This technology allows exact locations.
  - ◊ adaptation for rail may be easier than with bus service

Continued on next page

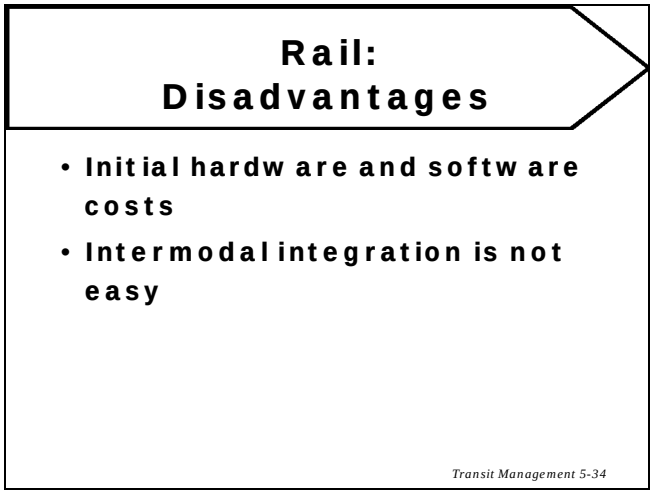
Applications: Rail, Continued

Rail costs

Costs for rail software systems:

- can include hardware and software costs
- can be designed for a range of budgets:
  - ◊ Know what you're getting by being very detailed in your design specifications if you choose a custom solution.
  - ◊ Many systems are becoming more "modular," so they can be purchased a piece at a time and upgraded and added to as time and budgets move forward.

Slide: Rail: Dis-advantages



Rail costs

Review any item on the slide that was not covered already.

Disadvantages include:

- initial hardware and software costs
- intermodal integration is not easy

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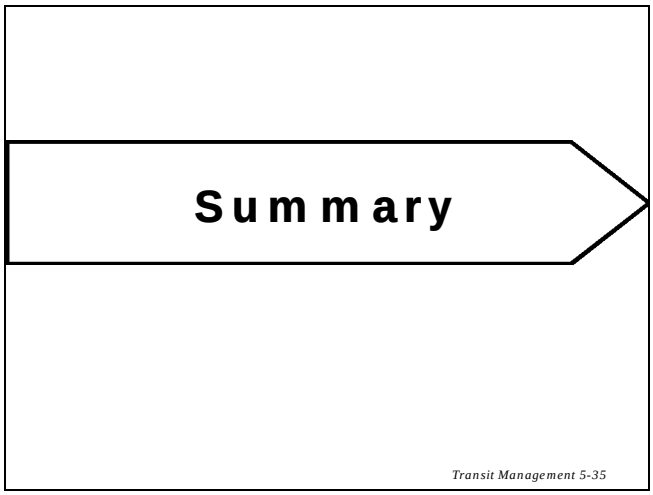
Applications: Rail, Continued

Slide: Summary



Summary

Explain resources that will provide students with additional information. Refer to the appendix for listings of related courses.

Transit Management Training Course	Title	ITS Professional Capacity Building		NTI course
		Technical Seminars	Short Courses	
Module 5: Transit Operations Software	Geographic Information Systems: Transit Applications			x
	Improving Transit System Performance: Using Information-Based Strategies			x
	Reinventing Transit: Using Information Technologies to Reinvent Transit Services			x

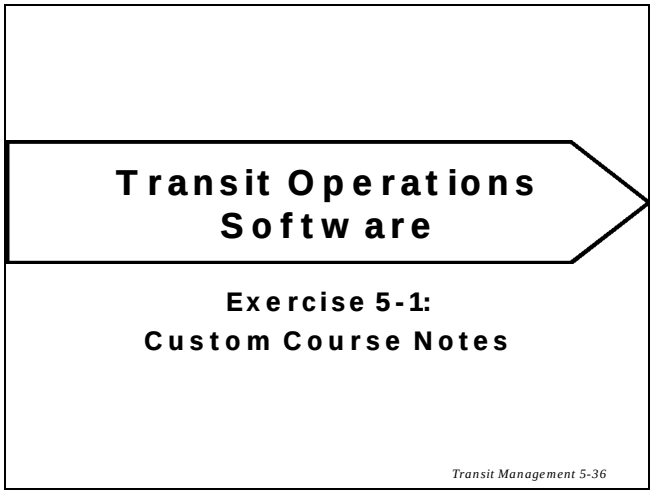
TABLE 5-1: APTS TRANSIT OPERATIONS SOFTWARE TECHNOLOGY REFERENCE

Technology	*Description*	*Costs, Benefits, and Risks*
Fixed Route Bus		
Intelligent Vehicle Logic Unit	Contains hardware and software and is placed on the bus to combine Automatic Vehicle Location and automatic operations software	• Provides real-time information which facilitates security and safety
Geographic Information Systems	A mapping system which is a combination of an electronic map and a database	• Can combine data from seemingly unrelated systems onto one map
Transit Control Center	An organization providing local or regional multi-occupancy vehicle passenger service	• Automatic operations software allow the transit control system to efficiently monitor location, adhere to scheduling, and know the real-time location of each vehicle
Computer-Aided Dispatch	Collection and processing of transit data from external sources by one computer and the control center display of processed information by the other	• Improves operation by aiding the dispatcher in quickly processing information
GPS Base Stations	Receives latitude and longitude coordinates from transit vehicles, converts that data into map coordinates, and plots the locations on the GIS display map	• State-of-the-art informational transfer process, but satellite time is expensive
Mapping Software	Situation map which displays location, status, and schedule adherence of all vehicles in the system	• Ties in peripheral data into a single map
Rail Automated Operations Technology		
Rail Control Centers	Provides general fleet management, including vehicle location, schedule adherence and emergency communication	• Can be expensive but provides efficiency at a cost affordable to the consumer
Automatic Train Supervision	Automatic train supervision enhances customer services by providing data to in-terminal and in-vehicle automated transit systems	• Mechanical systems are automatically monitored and real-time data sent back to dispatch. Vehicle identification allows the dispatcher to determine location and reroute if necessary.
Advanced Rail Control Systems	Provides improved information flow, evaluation of on-time performance, and emergency response	• Increases safety and security as well as operational efficiency; costs for rail software systems can be high, depending on design

Exercise 5-1: Custom Course Notes

Length 30 min.

Slide: Exercise 5-1



Leader instructions

Read the "In this exercise" and the directions to the class.

Say:

- Turn your student guides to the Chicago Transit Authority case study on page _____. Read the case study, then answer the questions on page _____.

- **Allow** ten minutes for the students to read the case study and answer the questions.

Note to instructor: *This exercise continues after the questions.*

In this exercise

You will:

- be able to describe the possible benefits of using Transit Operations Software in your transit systems

Continued on next page

Exercise 5-1: Custom Course Notes, Continued

Directions Read the example provided and answer the questions that follow

Case Study: Chicago Transit Authority (CTA)

The Chicago Transit Authority is implementing APTS technologies through its Bus Emergency Communications System (BECS) and Bus Management System (BSMS).

- The BECS is a fully integrated communications base that enhances the effective delivery of bus service using a new two-way voice and data radio system.
  - ◊ CTA expects to have approximately 1500 buses outfitted by the end of summer 1999.

Continued on next page

Exercise 5-1: Custom Course Notes, Continued

Case Study: Chicago Transit Authority (CTA), *continued*

- The BSMS is a demonstration of several APTS technologies, including computer-aided dispatching, which provide schedule and headway adherence monitoring for about 250 buses operating on two of CTA's major routes.
  - ◊ When the location data show that there is a problem on the street, the BSMS will assess the current situation on the street and compare it to ideal conditions, as previously defined.
  - ◊ The BSMS will then suggest alternative corrective actions to the dispatcher.
  - ◊ The dispatcher can then choose from among the alternatives and issue instructions to the relevant drivers.
  - ◊ The BSMS will also test traffic signal priority at five major intersections and will provide displays that show actual expected arrival times to waiting passengers at two bus stops.
  - ◊ The BSMS will also provide ATIS to wayside bus stops, including schedule adherence.

These tests will use standard interfaces that will allow CTA to consider adding other fleet management functions after system-wide deployment of both systems.

Source: APTS State-of-the-art Update '98, p. 2-37

Continued on next page

Exercise 5-1: Custom Course Notes, Continued

Question 1 List the technologies that CTA uses.

Question 2 What benefits might CTA experience because of the CAD application they are installing?

Question 3 If you decide to increase the automation of your control center, what tasks do you feel need to be automated first? How will these steps affect your staffing and/or training needs?

Continued on next page

Exercise 5-1: Custom Course Notes, Continued

Turn to Module 10

When students are finished with Exercise 5-1, direct them to Module 10.

Say: Open your book to Module 10, page _____. Using the student guide's information about Transit Operations Software and your knowledge of your own region and agency, respond to each item as follows:

- In **item 1**, circle the technologies that are currently used in your region. Highlight potential technology for future applications.
- In **item 2**, read each of the questions and answer yes or no. "Yes" answers suggest your interest in Transit Operations Software.
- Read **item 3** to identify which actions you would take toward obtaining TOS.
- In **item 4**, tell the students to write their own action items and/or ideas that this module suggests to them. For example:
  - ◊ Are there any questions you want answered?
  - ◊ Were there any web sites that you wanted to look at when you return to the office?
  - ◊ Were there any courses or resources you wanted to find out more about?
  - ◊ Did we mention any transit example that you want more information about — who can you contact and where?

Continued on next page

Exercise 5-1: Custom Course Notes, Continued

For more information For additional information, use the following table to look up additional examples of what is going on in the field.

Automatic Vehicle Location Systems Examples			
Technology	**Story**	***Update '98***	**Additional info**
Bus: GIS	• Cape Cod Regional Transit Authority, MA	p. 2-9	Prototype system to help decide on next steps
Bus: Transit Control Center	• Montgomery County, MD	p. 2-33	*Update '96,* p. 40
Bus: CAD / AVL	• Seattle, WA	p. 2-36	Software upgrade of existing system
	• New York Transit, NY	p. 2-39	In design and construction phase of deployment
	• Milwaukee, WI	p. 2-34	Upgrade of a 1992 system. See also *Update '96,* p. 40
	• Tri-Met in Portland, OR	p. 2-37	Upgrades being tested, VLUs
Rail: Operations Control Center	• Bay Area Rapid Transit, CA	p. 2-42	Integration with 22 year old train monitoring system
	• MBTA in Boston, MA	p. 2-43	Centralize control and information processing
Rail: Computer Simulation	• SEPTA in Philadelphia, PA	p. 2-45	Integrated with GIS and design software
Rail: Train control system	• Tri-Met in Portland, OR	p. 2-46	Fiber optic cable line connection
	• St. Louis, MO	p. 2-47	Tracks and controls trains